



Transport Canada
Road Safety

Transports Canada
Sécurité routière

Ergonomics Division

International Harmonized Research Activities:
Intelligent Transport Systems

Workshop:
ITS Safety Test & Evaluation
April 14-15, Washington, DC

Y. Ian Noy
Chair, IHRA-ITS WG
Transport Canada

330 Sparks St., Ottawa, Ontario, K1A 0N5
Tel: (613) 998-2268 Fax: (613) 998-4831 NOYI@tc.gc.ca

Canada

Introduction

The IHRA-ITS Working Group convened a two-day Workshop on ITS Safety Test & Evaluation in Washington, DC, April 14-15, 1999. The goals of the workshop were to consider research needs and opportunities and formulate priority projects that can advance ITS safety test and evaluation methodology through collaborative international research. Nearly 50 researchers from research organizations and universities worldwide participated in the workshop. The workshop was structured around four main domains of research (which are not mutually exclusive); direct safety, behavioural adaptation, workload and usability.

- Direct Safety Effects (e.g., conflicts, incidences) - measured outcomes in terms of safety, including collision or incident frequency, conflicts and safety-critical errors
- Behavioural Adaptation - behaviours which may occur following the introduction of changes to the road-vehicle-user system and which were not intended by the initiators of the change
- Workload (e.g., visual demand, distraction) - the portion of the driver's maximum mental resource capacity expended in the performance of the driving task
- Usability (e.g., errors, time) - the extent to which a system or device is effective, efficient, satisfying, easy to learn and control, and is compatible with task goals in the driving environment.

Four keynote presentations provided an overview of each topic, after which the delegates were divided into four breakout groups. The Nominal Group Technique was used by each group to formulate research problem statements.

This process resulted in the definition of 16 research problem statements, which are documented in this report. The IHRA-ITS Working Group selected 7 of these for priority implementation.

IHRA-ITS WORKSHOP APRIL 14-15, 1999

PROJECT PRIORITIES

1. NORMATIVE DATA ON NATURALISTIC DRIVING BEHAVIOR	4
2. THE IMPACT OF ITS SYSTEM INTEGRATION ON DRIVER BEHAVIOUR AND PERFORMANCE.....	5
3. “THE AUTOMATED GUARDIAN”: AN AUTOMATED WORKLOAD MANAGEMENT SYSTEM.....	6
4. DEVELOPMENT OF A HARMONIZED SAFETY EVALUATION METHODOLOGY FRAMEWORK FOR ITS (WORLDWIDE).....	7
5. SIMULATOR REFERENCE TEST SCENARIOS	8
6. IMPROVED SECONDARY TASK METHODOLOGY FOR EVALUATING SAFETY EFFECTS OF DRIVER WORKLOAD.....	9
7. DEVELOPMENT OF MACHINE VISION TECHNIQUES FOR AUTOMATED EVALUATION OF EYE MOVEMENT.....	10
8. DRIVING PERFORMANCE OBSERVATION BY TRAINED OBSERVERS	11
9. HARMONIZATION AND VALIDATION OF SURROGATE SAFETY MEASURES	12
10. DRIVER UNDERSTANDING AND EXPECTATION OF ITS SYSTEMS	13
11. DRIVER LEARNING, RETENTION, AND ACCEPTANCE OF NEW ITS SYSTEMS: WHAT WE CAN LEARN FROM PAST EXPERIENCE.....	14
12. THE EXTENT TO WHICH DIFFERENT FACTORS AND THEIR INTERACTION INFLUENCE BEHAVIORAL ADAPTATION.....	15
13. HUMAN FACTORS PRINCIPLES CHECKLIST FOR VEHICLE CONTROL SYSTEMS	16
14. MICROSIMULATION BASED PREDICTION OF SAFETY	17
15. ADAPTATION TO REAR END COLLISION AVOIDANCE SYSTEMS	18
16. CATEGORIZATION OF SUBJECTS, SYSTEMS, MODALITIES ETC. RELEVANT TO INTELLIGENT TRANSPORTATION SYSTEMS	19

1. NORMATIVE DATA ON NATURALISTIC DRIVING BEHAVIOR

1.1. Objective:

The purpose of this project is to characterize driving behaviour in realistic situations by developing a driving performance database which comprises data on normal driving behaviour, in-vehicle ITS system usage, safety critical events, and crash data.

1.2. Statement of need or justification:

Data is needed on real world driving behaviour to provide valid indications of the “normal driving envelope”. The information from this project would provide a basis for a general driving model against which changes in driving performance and behaviour could be evaluated. Data from this project would be valuable for generating driving scenarios for use in future research and would aid in the development of the “Simulator Reference Test Scenarios” project. It could also assist in the evaluation of surrogate safety measures as described in the “Harmonization and Validation of Surrogate Safety Measures” project.

1.3. Elaboration of the specific question to be addressed:

The focus of this project is on the driver and everyday driving behaviour. Measures would capture the typical performance for a variety of driving variables, characterize normal variability in driving behaviour, and provide an indication of safety critical situations for driving. Much is to be gained from this long term intensive study of driving behaviour. For example, with sufficient data it may become apparent that safety critical situations are ITS system specific. The extended time frame of this project permits the study of behavioural adaptation to new ITS systems. This type of behavioural change is not immediately apparent and would provide a particularly important contribution to the study of safety. The project will include different driving populations with the goal of characterizing differences in behaviour for drivers of different cultures, ages, skill levels, and locations (rural and city).

1.4. Approach to Project:

This work is, by definition, a long term project and would involve continuous data collection. Work, however, has been started in this area. Data would be gathered for driving behaviour, driving performance, and in-vehicle system usage. Real time observations could be made of drivers doing their everyday driving over a long term. Data could be collected by video and sensors in vehicle with the possible use of blackbox and surveillance tools.

2. THE IMPACT OF ITS SYSTEM INTEGRATION ON DRIVER BEHAVIOUR AND PERFORMANCE

2.1. Objective:

The goal of this project is to perform analytic and empirical research to examine driver workload effects due to multiple sources of in-vehicle information. The impact of ITS devices on allocation of attention and detection of hazards will be investigated.

2.2. Statement of need or justification:

Vehicles are becoming increasingly complex (and more like planes) and drivers must deal with many systems while driving. Safety may be compromised because drivers may have too much information or too many sources of information to deal with.

2.3. Elaboration of the specific question to be addressed:

ITS devices reduce workload, often by assisting drivers in monitoring the road for potential hazards. This assistance may result in a re-allocation of attention. For example, in VES attention may be directed towards the enhanced area, for navigation systems towards the display, and for ACC to other non-driving tasks inside the vehicle. As a result, attention to potential hazards may be inappropriately reduced resulting in delayed detection and degraded safety.

2.4. Approach to Project

The development of design guidelines would be the first goal of the project. Subsequent work would provide a priori workload estimation techniques for new in-vehicle devices which need not necessarily be already built. Because the real world is far richer in visual stimuli than any simulator or test track, studies looking at re-allocation of attention when a task is aided should be done in real traffic using eye movement recording. Detection of potential hazards (pedestrians, slowing vehicles, etc.) should be determined with and without the ITS system.

3. “THE AUTOMATED GUARDIAN”: AN AUTOMATED WORKLOAD MANAGEMENT SYSTEM

3.1. Objective:

The goal of this project is the development of a system for monitoring driver status which would detect individual driver impairment based on a multi-sensor data algorithm. The system would monitor driving conditions and driver performance and be capable of sensing, processing, and control such that it could provide compensatory automated support to driving.

3.2. Statement of need or justification:

The measurement of workload Impaired driving as a consequence of (high or low) workload is dependent on individual capabilities and should be determined on individual performance changes. Distraction due to driver workload and fatigue states changes over time and during certain tasks. A system that tracks driving performance and provides support to the degraded driver is desirable.

3.3. Elaboration of the specific question to be addressed:

Automated vehicle control systems automate the vehicle and make the driver a system monitor. The concept of an “automated guardian” reverses this notion and puts the driver in the control loop and makes the automation the monitor. The idea is that automation would modulate driver control inputs as appropriate and when appropriate. We would require multidimensional criteria for driver impairment, with various ITS applications, comparing driving performance to subjective data, physiology, and expert opinion.

3.4. Approach to Project

The approach to this project would involve the analysis of sensed information requirements and driver workload models, and the analysis of driver preferences. It would involve algorithm implementation for stability and controllability and integration of sensors, control system, and vehicle. Testing would be done on simulators and test tracks. Since we would want to push the subjects to the limit, simulator studies would be required. However, road tests would be necessary later in development to test the algorithms in real world situations.

4. DEVELOPMENT OF A HARMONIZED SAFETY EVALUATION METHODOLOGY FRAMEWORK FOR ITS (WORLDWIDE)

4.1. Objective:

The objective of this project is to develop a Harmonized Safety Evaluation Methodology Framework for in-vehicle information, control, and communication systems with respect to human performance and behaviour.

4.2. Statement of need or justification:

To complement current international efforts to develop ITS standards and operational requirements, there is a need for reliable, valid, and efficient procedures that can be used for evaluating the safety of on-board ITS devices. At present, the results of safety research in the public domain are often not comparable due to differences in methodologies and underlying assumptions. A safety evaluation framework would facilitate the interpretation and comparison of research findings and result in a coherent accumulation of information. This expanded knowledge base would in turn provide direction for future research and development. The framework could also permit the examination of cross-cultural and regional differences.

4.3. Elaboration of the specific question to be addressed:

The evaluation framework would include specified test measures as well as the appropriate statistical methodologies to be used with them to assess the safety impact of various ITS systems. It would incorporate a variety of measures and criteria to determine direct safety effects, behavioural adaptation, workload, and usability. Standard testing conditions would be outlined (with respect to driver and driving conditions). Specific techniques for assessment would be included as well as the appropriate benchmarks or indicators of acceptable performance levels to be used with them. The framework would be based on research and updated as progress in relevant research is made.

4.4. Approach to Project

As a starting point, it is suggested to elicit expertise that currently resides within the automotive industry and research organizations through a series of workshops. It is recognized that in the course of product development and demonstration, a number of organizations have developed techniques for assessing direct safety, workload, behavioural adaptation, and usability. It is important to share, analyze and document these techniques. The resulting first cut of the framework would be applied to the evaluation of a variety of ITS products and refined based on experience. Complementary studies would investigate the reliability and validity of the various techniques referenced in the framework. The expertise of industry should be an integral part of developing a common framework.

5. SIMULATOR REFERENCE TEST SCENARIOS

5.1. *Objective:*

The goal of this project is to develop a catalogue of driving scenarios for use in driving simulator research. The set of scenarios should encompass the breadth of driving possibilities from uneventful everyday situations to safety critical situations.

5.2. *Statement of need or justification:*

There is a need for standardized scenarios for use in research to ensure that all appropriate conditions are being investigated and to facilitate comparisons across studies regardless of country and/or research institution. These scenarios can then be employed in research investigating driver use, behaviour, and performance for different ITS applications (alone or in combination). A library of standardized scenarios would also be a great benefit when setting up and calibrating driving simulators.

5.3. *Elaboration of the specific question to be addressed:*

The database would include scenarios for both normal driving and safety critical situations in city and rural locations. A variety of road configurations, representative of the driving environment (including both city and highway driving) would be included. Each scenario would be available in multiple versions using different combinations of characteristics (e.g., traffic density, light conditions, weather conditions, etc.) to facilitate experimental control. Other aspects to be considered involve the control of the situation depicted in the scenario and include onset of episode, timing of events during the episode, and duration of episode. Guidelines for research, based on data, could be provided for representative combinations of variables to use.

5.4. *Approach to Project:*

The project would begin with the delineation of appropriate scenarios for the database and the various characteristics and variables to be included. The scenarios should be representative of the driving environment and design characteristics of road. The project “Normative Data on Naturalistic Driving Behaviour” would be an excellent source of information for driving scenarios. Other databases, such as those containing crash data, would be valuable sources of driving scenarios.

6. IMPROVED SECONDARY TASK METHODOLOGY FOR EVALUATING SAFETY EFFECTS OF DRIVER WORKLOAD

6.1. Objective:

The goal of this project is to develop a useful secondary task methodology to calibrate workload effects of combining in-vehicle and out-of-vehicle information

6.2. Statement of need or justification:

A secondary task methodology approach to workload involves the use of a second, non-driving task to evaluate driving workload effects. In previous research, Harms (1986) was able to relate secondary task performance to on-road fatal crashes, demonstrating the value of secondary task methodology in the study of safety. The goal of the current project is to extend this technique to the study of safety and ITS. The ultimate goal would be the creation of an objective workload redline.

6.3. Elaboration of the specific question to be addressed:

Workload can be measured using objective performance measures, subjective measures, and physiological measures. However, the appropriate control conditions and independent variables are not always included in these studies. The goal of this project is to specify a set of clearly defined secondary tasks which are sensitive to in-vehicle and on-road driver workload. Secondary task methodology has often been used in behavioural research but the theoretical assumptions underlying the technique are complex and interpretation of the data is often not straightforward. The goal of this project is to take what is useful from the past research and apply these methods to the study of safety and ITS.

6.4. Approach to Project:

The work would begin with a review of secondary task methodologies with a view to determining which methodologies would be appropriate for driving research and ITS research in particular. Once appropriate methods are determined, further testing for feasibility, reliability, and validity would be undertaken. This project could involve both simulator and on-road testing.

7. DEVELOPMENT OF MACHINE VISION TECHNIQUES FOR AUTOMATED EVALUATION OF EYE MOVEMENT

7.1. Objective:

The goal of this project is to develop machine vision techniques for use in the automated evaluation of eye movements.

7.2. Statement of need or justification:

The monitoring of eyemovements provides important data for safety research. However, the use of these procedures is limited because current methods for data analysis are very labour intensive. The commercial demand for such a system may be insufficient to support its development.

7.3. Elaboration of the specific question to be addressed:

The evaluation of eyemovement data is a complex problem. Automation of this process will require expertise in machine vision methodology. There are many specifications that a useful system must meet and it must be reliable and easy to use.

7.4. Approach to Project

Machine vision techniques would be used in this project.

8. DRIVING PERFORMANCE OBSERVATION BY TRAINED OBSERVERS

8.1. Objective:

The goal of this project is the development and validation of a standardized protocol for trained observers to for evaluating drivers while they drive.

8.2. Statement of need or justification:

There is need for a well developed and standardized protocol in this area. The use of trained observers provides an inexpensive approach to driving research.

8.3. Elaboration of the specific question to be addressed:

The protocol could be useful for evaluating driver performance and behavior when using new or existing systems in cars. A variety of behavioural dimensions could be employed depending on the particular research question being investigated. Subscales might be included to assess particular dimensions of driving behaviour. Clear instructions for use of the scales would be developed. Standards for the evaluation would be beneficial in that they would minimize between rater variability and allow comparisons across studies.

8.4. Approach to Project:

One approach would be to survey existing protocols and assess what might be incorporated into a larger, more developed product.

9. HARMONIZATION AND VALIDATION OF SURROGATE SAFETY MEASURES

9.1. Objective:

The goal of this project is the harmonization and validation of surrogate safety measures.

9.2. Statement of need or justification:

Surrogate measures are an important tool for ITS safety research and a variety of surrogate measures of safety are currently in use. The relationship, however, between the various measures and what they are purported to measure is not always agreed upon. There is also disagreement concerning the appropriate methodology for their use. As a result there is a need for harmonization and standardization of these measures. Until this is achieved, the usefulness of surrogate measures is undermined and meaningful comparisons across studies are difficult to make.

9.3. Elaboration of the specific question to be addressed:

Three main issues concerning surrogate measures must be addressed. First, surrogate measures must be operationally defined with unambiguous descriptions. Second, the relationship between the individual surrogate measures and safety must be empirically determined. Third, clear guidelines must be developed for the use of the measure including the specification of appropriate dependent variables. In addition, methods are also needed to compare studies using surrogate safety measures. A method to predict safety benefits would also be desirable.

9.4. Approach to Project:

The work would start with a survey of the various surrogate safety methods, what they are supposed to measure, and the methods and metrics used in those measures. Empirical work would be required to establish the links between the surrogate measures and safety.

10. DRIVER UNDERSTANDING AND EXPECTATION OF ITS SYSTEMS

10.1. Objective:

The goal of this project is to determine how well drivers understand ITS systems and the performance expectations they have for these systems. A second goal is to assess the safety consequences of mismatches between driver expectation and system performance.

10.2. Statement of need or justification:

Drivers have many different ITS applications available to them. They can equip their cars with ACC, navigation systems, and communication systems, among other things. Each system is designed to aid the driver in a different way and each has different operating characteristics. The picture is further complicated by the fact that for a particular type of ITS, such as ACC, system performance characteristics may vary from one vehicle/system to another. How well the driver understands the ITS application and the expectation he or she has for its performance can directly impact the safety of its use. The focus of the current project is an assessment of how well drivers understand what particular ITS applications can do.

10.3. Elaboration of the specific question to be addressed:

There is a need to assess drivers' understanding and expectations of the various ITS systems. ACC and navigation systems are two examples from current ITS technology that provide illustrative examples. We know from past research that drivers do not understand the capacities and limitations of standard cruise control very well. Driver understanding of ACC is not yet determined. We need to assess how well people are able to understand the reliability and limitations of ACC. Some ACC systems, for example, cannot reliably detect dirty, small, or stationary targets. It appears that multiple system types will be available to consumers to indicate the curve radius capability of the particular ACC system. This lack of system standardization may contribute to poor understanding and consequent safety hazards. A second example is provided by navigation systems where systems vary as to the mode and timing of information presentation to the driver. Some navigation/route finding systems may present the driver with turning directions at a different point than the driver might expect prior to a turn. These mismatches need to be identified, measured, and analyzed to prevent adverse safety effects. A better understanding of these problems could lead to design improvements in these systems.

10.4. Approach to Project:

This project could start with a review of accident data, focus groups, and/or usability studies to determine potential mismatches between designer intent and driver understanding and performance. The information gained could then be examined in experimental studies using simulators and test tracks. A variety of measures should be used to assess behavioural adaptation, driver acceptance, and performance.

11. DRIVER LEARNING, RETENTION, AND ACCEPTANCE OF NEW ITS SYSTEMS: WHAT WE CAN LEARN FROM PAST EXPERIENCE

11.1. Objective:

The objective of this project is to make use of available data from past introductions of ITS vehicle systems to indicate where potential problems might arise with the introduction of new systems. This knowledge would be used in an effort to avoid problems that were encountered in the past.

11.2. Statement of need or justification:

When a new ITS system is introduced, drivers must become familiar with its operation and skilled in its use. Information is needed that can be used to improve this process of learning and skill acquisition. An examination of problems that arose in the past when new systems were introduced can be instructive. Prior problems may have been due to consistently poor design or instructions for use. Alternatively, specific characteristics and habits of the people who use the systems may produce safety risks. In this project, the information gained from past introductions of ITS will be used to improve the design and introduction of new systems with a view to improving safety.

11.3. Elaboration of the specific question to be addressed:

Multiple factors contribute to the ease with which drivers can successfully and safely incorporate new ITS systems into their driving behaviour. Some systems may be difficult to use because of the characteristics of the system itself such as poor interface design, placement of the unit, ease of use, etc. Other difficulties arise because people must become familiar with the systems and learn how they work. The factors that could potentially affect safety when using a new ITS system are the ease, difficulty, and length of time required to learn the new system. Other factors with potential safety impacts are the retention of the newly acquired skill (a potential problem for occasional users), keeping system skills up to date, and individual differences in learning. Drivers may also be faced with multiple ITS systems to use. This raises the possibility of negative transfer from the use of previous models or alternative systems and introduces the potential for interference from the use of other in-car systems. Learning, retention, and acceptance of new ITS systems are likely to be influenced by driver characteristics such as age.

11.4. Approach to Project:

This work would start with a survey of previous research on the introduction of new ITS technologies and an examination of their impact on driving safety. This information could be obtained from archival data or focus groups. Usability studies could be conducted on existing systems or those currently being designed.

12. THE EXTENT TO WHICH DIFFERENT FACTORS AND THEIR INTERACTION INFLUENCE BEHAVIORAL ADAPTATION

12.1. Objective:

The goal of this project is to determine the interaction among safety, mobility, workload, and productivity while driving and the Behavioural Adaptation that arises due to these factors.

12.2. Statement of need or justification:

There is no question that drivers' behaviour is changed by the introduction of ITS systems in their cars. This project will identify the factors drivers aim to prioritize when using ITS. The knowledge gained will help to further understand the process of Behavioural Adaptation and could be used to design systems with the goal of avoiding negative safety consequences or encouraging actual improvements in safety.

12.3. Elaboration of the specific question to be addressed:

There is a need to identify any unknown changes in driver behaviour due to the use of ITS systems. What priorities do drivers set in terms of safety, mobility, workload, and productivity while driving. How do driver characteristics such as age, driving style, and skill, for example, impact these choices? How does driver understanding or misunderstanding of system operation affect these tradeoffs?

12.4. Approach to Project

Multiple approaches would be appropriate for this project such as surveys of user attitudes, focus groups, observational techniques and experiments employing a variety of performance measures. Studies could be carried out in simulators, using on-road studies, or test tracks.

13. HUMAN FACTORS PRINCIPLES CHECKLIST FOR VEHICLE CONTROL SYSTEMS

13.1. Objective:

The purpose of this project is to develop a checklist based on human factors principles to be used in the safety evaluation of vehicle control systems.

13.2. Statement of need or justification:

Similar types of checklists are already available and have proven useful in other applications such as the evaluation of information systems. The value of this type of approach is that it provides a relatively quick, prospective evaluation method that can be used as a “first filter” by experts to evaluate a system during design or at the early stages of development. An additional benefit of the checklist is that it provides an easy to use, consistent evaluation method which would also assist in dialogue with manufacturers.

13.3. Elaboration of the specific question to be addressed:

Human factors research provides us with a wealth of information relevant to the design of ITS systems. A checklist based on human factors principles would incorporate this knowledge into an easy to use format. The checklist could be used to detect design characteristics that could lead to information conflict, information overload, or loss of situation awareness. Use of the checklist would help to ensure that drivers receive information concerning distance, system malfunction, and severity of the situation, for example, in the safest and most efficient manner. Other human factors considerations to be considered involve user interface consistency, operation consistency across platforms, ease of learning, skill with the system, and appropriate design to accommodate individual differences.

13.4. Approach to Project:

A first step would be to investigate similar checklists already in use. It is likely that such checklists have been developed for specific ITS implementations and these could be built upon or incorporated into a more comprehensive version. An alternative approach would be to start with the general human factors principles first and then generate a checklist. Once developed, the checklist could be validated on existing ITS systems.

14. MICROSIMULATION BASED PREDICTION OF SAFETY

14.1. Objective:

The goal of the this project is to develop a system that could be used to generate predictions of safety for new ITS applications using microsimulation procedures prior to market penetration.

14.2. Statement of need or justification:

There is great benefit in knowing what potential safety problems might arise in a new ITS application prior to its market release. This early form of evaluation could also enable developers to correct problems in the ITS systems before the products are finalized.

14.3. Elaboration of the specific question to be addressed:

The main purpose of the project would be to measure safety but it could be used for additional purposes.

14.4. Approach to Project:

Microsimulations of critical ITS implementations would be designed and run. Validation of the simulation results would be essential.

15. ADAPTATION TO REAR END COLLISION AVOIDANCE SYSTEMS

15.1. Objective:

The goal of this project is the evaluation of drivers' short and long term adaptations to rear end collision avoidance systems. These are systems that use high levels of braking ($> .25\text{ G}$) in response to slower moving or stopped vehicles.

15.2. Statement of need or justification:

We do not yet have data on how drivers will adapt to these systems and the sorts of behavioural change that will ensue as a result of their implementation.

15.3. Elaboration of the specific question to be addressed:

Systems are coming to market which will apply high levels of braking as convenience to drivers. Future systems will be capable of responding to stopped vehicles and objects. As a consequence of these developments, drivers' roles will change and they will serve primarily as system monitors. These new systems may increase safety by alerting drivers to hazards and by providing longer times to react to driving situations. The systems may, however, deprive drivers of needed practice in modulating braking. Drivers may also develop unrealistic expectations, or increase risky behaviour (e.g., taking eyes off the road) as a result of having these systems in their cars. The specific adaptation effects may differ for experienced drivers and new drivers who have no experience with older versions of the systems. Previous research has provided evidence of driver behavioural change due to the introduction of ABS systems.

15.4. Approach to Project

Multiple approaches would be taken to this project. Short term adaptations could be addressed in simulator studies. Long term effects would require longer term field tests.

16. CATEGORIZATION OF SUBJECTS, SYSTEMS, MODALITIES ETC. RELEVANT TO INTELLIGENT TRANSPORTATION SYSTEMS

16.1. Objective:

The aim of this project is to develop a taxonomy of research elements for use in ITS research.

16.2. Statement of need or justification:

There is a need for a comprehensive knowledge base of all relevant variables (and the appropriate levels of those variables) to be used in ITS research. These would include, but would not be limited to, various available ITS systems, the modalities available for presentation of information, subject variables (including behaviors and characteristics such as psychological, perceptual, and physical ones), as well as other variables relevant to ITS research.

16.3. Elaboration of the specific question to be addressed:

The project would result in a compendium of research-relevant variables across several dimensions. A possible offshoot of this project would investigate whether there are standard tests (e.g., perceptual, cognitive, and behavioral) that could be usefully applied in research on ITS safety.

16.4. Approach to Project:

The project would begin with a compilation of variables and potential measures currently in use. Additional measures and tests would be incorporated as necessary.